Section 19 Contents

19.1	Introduction	19-1
19.2	Subsurface Geology and Aquifer Characteristics	19-1
19.3	Groundwater Problems and Alternatives in the East Shore Area	19-7
19.4	Issues and Recommendations	19-7

Table

19-1	Aquifer Characteristics - Weber River Groundwater Basins	19-4

Figures

19-1	Hydrologic Subareas Showing Groundwater Basins	19-2
19-2	Weber Basin Groundwater Pumpage	19-3

19 SECTION Groundwater

UTAH STATE WATER PLAN - WEBER RIVER BASIN PLAN

Groundwater is an important element of the overall hydrologic system in the Weber River Basin. Groundwater aquifers serve as large underground reservoirs providing substantial amounts of water for a variety of users.

19.1 Introduction

This section presents a comprehensive assessment of groundwater conditions in the Weber River Basin. It includes a description of geologic and hydraulic characteristics of existing groundwater aquifers, a general assessment of water quality associated with each groundwater basin, and discussions of groundwater management and supply issues. The groundwater basins are shown on Figure 19-1.

Groundwater is an important source of water for a broad range of uses including agricultural irrigation, secondary irrigation, municipal culinary water and industrial supplies. Currently, groundwater accounts for roughly half of all M & I water sources. Individual farmers and ranchers, municipalities, water districts, and companies and individual corporations all own and operate wells that withdraw an estimated 97,200 acre feet of water annually from the basin's six basic aquifer systems. A summary of pumpage by all uses for the East Shore Area is shown on Figure 19-2.

The aquifers within the Weber River Basin have unique geologic and hydraulic characteristics, water quality and current utilization practices. Each aquifer has distinct and differing capabilities of providing a reliable and safe water supply for the various beneficial uses.

In years past, groundwater supplies have been adequate to supplement surface water supplies to meet existing domestic and commercial water demands. But the recent increase in M&I water demand has dictated that new wells be developed. The need for additional groundwater withdrawals has also created water supply problems; the most dominant of which is the steady decline of groundwater levels in some of the most heavily pumped aquifers. In the East Shore Area, groundwater levels have declined between 50 and 80 feet since the mid-1950s.

19.2 Subsurface Geology and Aquifer Characteristics

As shown on Figure 19-1, the Weber River Basin consists of six groundwater basins which, although connected by surface flows, are generally considered geologically isolated.

The East Shore Area is the most fully developed groundwater basin in terms of annual pumpage for agricultural and M&I water demand. Except for the Park City area, groundwater is produced mostly from unconsolidated alluvium and lake deposits. No significant subsurface flow occurs between basins. Geological and hydraulic data for the six groundwater basins are summarized in Table 19-1.

9.2.1 East Shore Area Groundwater Basin

The East Shore Area is a string of coalescing alluvial fans and river deltas on the hanging wall of the Wasatch Fault. They are composed of multiple layers of sand and gravel deposited at the mouths of canyons, becoming finer westward into the Great Salt Lake Basin and sandwiched between clay layers deposited during high water levels of several ancient lakes. Interpretation of geologic data indicates unconsolidated or poorly consolidated deposits may be 9,000 feet thick near Ogden, and about 2,500 feet thick toward the north and south ends. The unconsolidated deposits are underlain at great depth by consolidated rock of Precambrian to Tertiary age whose properties have not been explored.

Figure 19-1

HYDROLOGIC SUBAREAS SHOWING GROUNDWATER BASINS

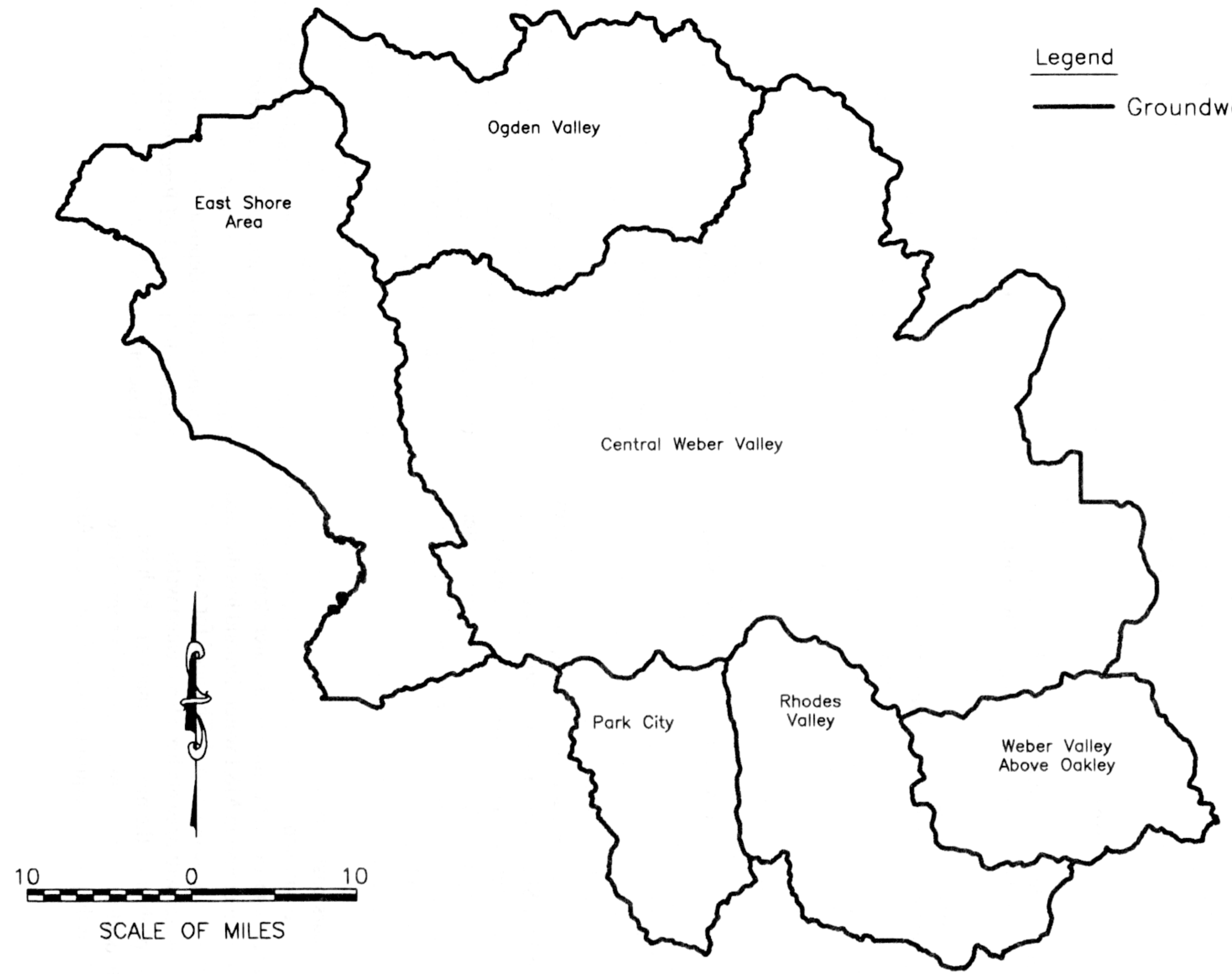

Figure 19 - 2

WEBER BASIN GROUNDWATER PUMPAGE

East Shore Area

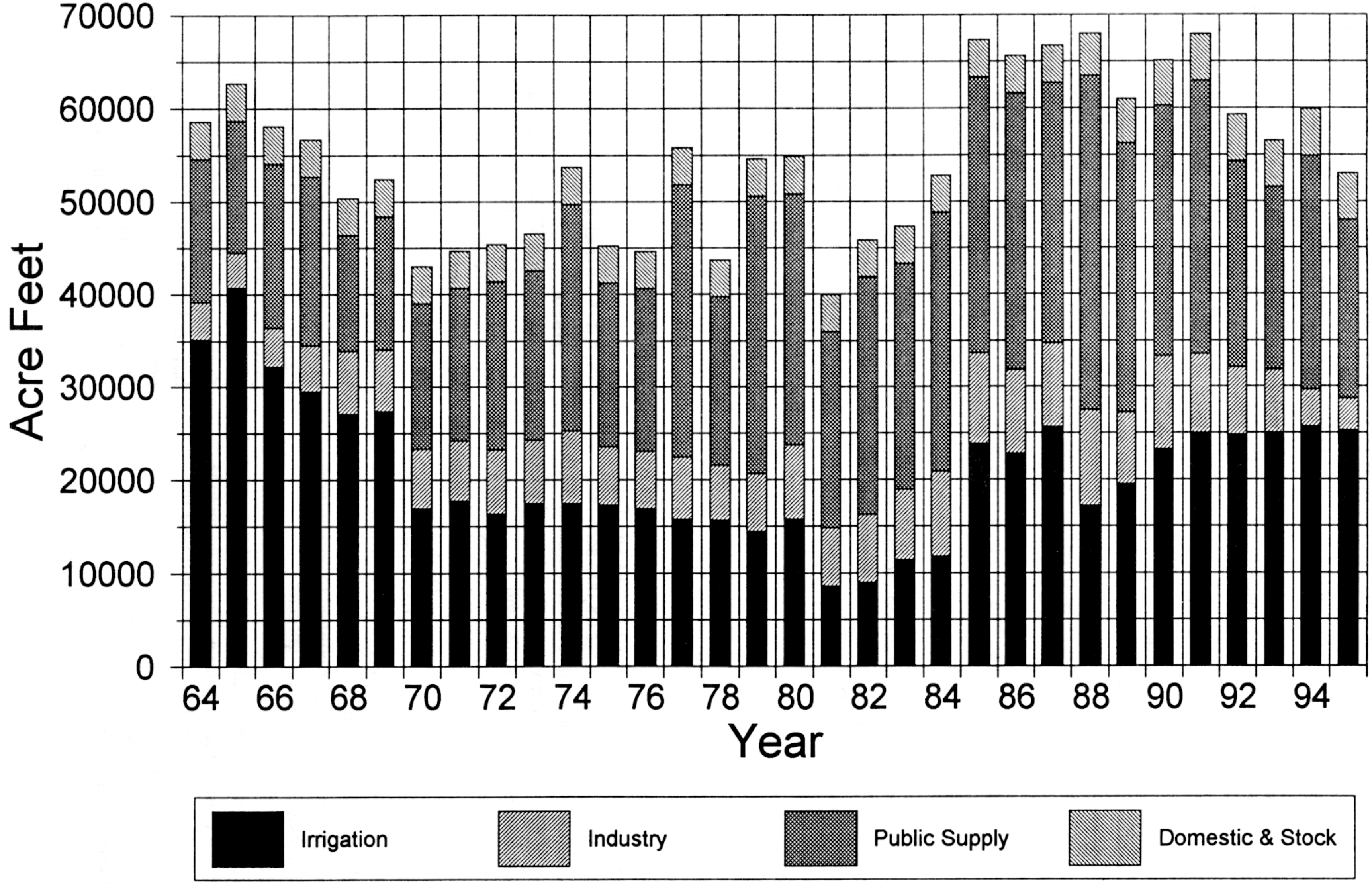

Table 19-1
AQUIFER CHARACTERISTICS-WEBER RIVER GROUNDWATER BASINS

Name	Aquifer	GW Model	Pumpage (acre-feet)	Chemical Quality	Water Right Status
East Shore Area	Alluvium/Lacustrine	Completed	68,000	Good[a]	Open
Central Weber Valley	Alluvium/Bedrock	Partial	3,000	Good[b]	Closed
Rhodes Valley	Alluvium	None	1,900	Good	Closed
Weber above Oakley	Alluvium	None	1,000	Good	Closed
Park City Area	Alluvium/Bedrock	In Progress	5,600	Good[c]	Closed
Ogden Valley	Alluvium	In Progress	17,700	Good	Closed
Totals			97,200		

a Some small areas of poor quality; potential for salt water intrusion from the Great Salt Lake.
b Some water from the Frontier and Wanship Formations near Coalville are "coally" with high dissolved iron.
c Some local problems with sulfate and heavy metals.

The USGS has recently completed groundwater models for the East Shore Area basin concentrating on the Weber River delta and Bountiful subareas. These models generally predict the consequences of various management strategies. A large volume of recoverable water appears to be in storage compared to the average annual discharge. This has given water managers some flexibility in managing the groundwater reservoir in conjunction with variable surface supplies.

Average annual discharge from the East Shore Area aquifer system is estimated to be 125,000 acre-feet. Discharge from wells accounts for 68,000 acre-feet, approximately half of the total. The remainder is 57,000 acre-feet of seepage to waterways and springs, the Great Salt Lake, uncapped artesian wells, and evapotransportation by surrounding wetlands.

Recharge to the East Shore Area aquifer is estimated to average 121,000 acre-feet per year. Of this, an estimated 48,400 acre-feet is infiltration from streams and canals with 60,500 acre-feet bedrock inflow. The remainder is 8,100 acre-feet from precipitation and 4,000 acre-feet from irrigation water applied to agricultural fields and residential lawns and gardens.

Because of the size and potential storage in the East Shore Area aquifer, additional water could be developed with several management options. This could include artificial recharge of surplus surface runoff near the mouth of Weber Canyon.

Water quality associated with the East Shore Area groundwater basin generally meets all state and federal standards for culinary water use. The highest quality of groundwater is typically found in the principle aquifers near the Weber and Ogden rivers deltas. These aquifers are also being recharged the most rapidly. However, in areas radially outward to the west of the two deltas, groundwater quality deteriorates as a function of depth. Groundwater quality generally decreases substantially below depths of 1,200 feet. In the northern part of the East Shore Area, pockets of brackish water exist that are possibly related to deep circulation of thermal water near Utah Hot Springs.

19.2.2 Central Weber Valley Groundwater Basin

The Central Weber Valley area is characterized by thin alluvial deposits along the Weber River and its tributary streams. In Morgan Valley, the alluvium depth has been approximated at 200 feet in most areas; however, actual thickness varies with location with some areas estimated at less than 100 feet. The alluvium is underlain by a variety of consolidated rock units ranging in age from Precambrian to Tertiary. The younger conglomerates and coarse clastic rocks, mainly the Echo Canyon, Evanston and Wasatch formations, are locally permeable and yield up to 560 gpm of good quality water to wells. Cretaceous sandstones around Coalville yield fresh to somewhat brackish water. The older formations have not been tested but probably have minimal permeability. Most of the groundwater is produced from the alluvium, which is hydraulically connected to and recharged by surrounding surface streams.

Most of the discharge is by pumping (3,000 acre-feet per year) and seepage to streams. Most of the recharge is from infiltration of precipitation and snowmelt. Details of this subarea are given in Bates and others (1984).

Water quality generally meets culinary standards for dissolved solids. The alluvial aquifer, however, is so thin and well-connected to surface water supplies, bacterial contamination may be a problem. Little or no testing has been conducted to assess the level of agricultural related organic contaminants. Water from some of the bedrock formations, such as the rocks of Cretaceous age near Coalville, may be high in iron or other inorganic solids.

19.2.3 Rhodes Valley Groundwater Basin

Rhodes (Kamas) Valley is a north-south, nearly rectangular, structural basin nine miles long and three miles wide lying between the Keetly volcanic field on the west and the Uinta Mountains on the east. The Weber River flows across the north end of the valley and receives drainage from a substantial portion of the aquifer. The basin fill is composed of coalescing alluvial fans deposited by intermittent drainages heading in the Uinta Mountains. These interfinger toward the center of the valley with fluvial gravels deposited by the Weber River and ancestral Provo River.

These unconsolidated deposits, estimated to be at least 300 feet thick, constitute the most important hydrogeologic units in the area. There appear to be no well-defined or continuous multiple aquifers or aquitards and no artisan conditions. Therefore, the water in the unconsolidated deposits is more or less hydraulically connected with the surface water and development of groundwater may have an immediate effect on spring discharge, surface flow and wetland areas.

Little is known of the bedrock deeply buried beneath the basin fill. Based on its occurrence in both a 1973 Kamas test well and a 1969 oil test on the west side of the valley, it has been demonstrated that the Weber quartzite probably extends under the entire valley and, if well fractured, may constitute a more productive aquifer than the alluvial fill. The 1973 test well was drilled east of Kamas at the mouth of Beaver Creek under a cooperative agreement among the Division of Water Resources, the Beaver and Shingle Creek Irrigation Company and the Weber Basin Water Conservancy District. The well penetrated 60 feet of bouldery alluvium, which proved unproductive. Beneath the alluvium, the well penetrated 305 feet of fractured Weber quartzite to a total depth of 365 feet. The well yielded 4 cfs (1800 gpm) for 26.5 hours with a drawdown of 71 feet; a specific yield of 25.4 gpm/foot of drawdown.

Recharge to the groundwater system in Rhodes Valley was estimated to be 22,000 acre-feet per year. This is a minimum value based on the average annual change in storage. Recharge is derived primarily from the infiltration of excess irrigation water with additional supplies from snowmelt.

In general, the groundwater quality within the Rhodes Valley basin meets and, in most instances, exceeds standards established for drinking water. In a few isolated cases, excessive dissolved solids and bacterial counts have created problems.

19.2.4 Weber Valley Above Oakley Groundwater Basin

The Weber River Valley upstream from Oakley contains substantial thicknesses of very permeable alluvial and glacial sand and gravel. A Bureau of Reclamation test well at the Larrabee Dam site penetrated 287 feet of alluvium and estimated the transmissivity at 2 ft^2/minute (2880 ft^2/day). The volume of water stored in the narrow valley fill is small with the aquifer hydraulically connected to surface streams. Current pumping rate from the aquifer has been estimated at 1,000 acre-feet per year.

19.2.5 Park City Groundwater Basin

Development in the Park City area is extending beyond the valleys to surrounding hillsides. As a result, the development of groundwater has expanded beyond existing basin fill materials to higher consolidated rock formations which allow for large aerial boundary extensions, large aquifer volumes and substantial depths. Consolidated rock aquifers not only yield water to wells, but feed most of the local springs and drain tunnels.

The Snyderville Basin and Park City Area contains two alluvial basins: Parleys Park, which drains to the Weber River via East Canyon; and Richardson Flat, which drains to the Weber River via Silver Creek. The unconsolidated basin fill consists of a poorly sorted mixture of material ranging in size from clay to cobbles and averaging 200 feet thick in Parley's Park and 100 feet thick in Richardson Flat. As in Rhodes Valley, there appears to be no well defined beds of very high or very low permeabilities and no indications of the existence of artesian conditions. The unconsolidated deposits are saturated to within a few feet of land surface, and are apparently recharged in many places by seepage from the underlying rock.

The largest part of local groundwater discharge is accounted for as annual pumpage (5,600 acre-feet per year), uncontrolled seepage or spring flow to surface streams. Consolidated rocks which yield water to wells include volcanic and volcaniclastic rocks, sandstone, limestone and shale. Compared to the unconsolidated valley fill, these rocks have comparatively high transmissivities and comparatively low storativities. Transmissivity is mostly due to fracturing. The more brittle the rock, the greater the probability it will sustain open fractures which will transmit water.

Transmissivities measured in boreholes and drain tunnels range from 3 ft^2/day in igneous rock, to several hundred ft^2/day in the Nugget sandstone and Weber quartzite, to several thousand ft^2/day in the Thaynes formation. Fracture permeability within a given rock unit is variable and depends upon the intensity of deformation. Vertical permeability is often as great as horizontal permeability. Wells in the Twin Creek limestone in the Summit Park-Timberline area show low production and large seasonal fluctuations in water level. This is an indication of local recharge through vertical fracture systems. Some artisan conditions are reported in the Nugget sandstone. The volcanic rocks are generally unproductive, but they may contain gravel channels or zones of brittle fractured rock which could be highly productive.

The Park City area is honeycombed with old mining tunnels and shafts that also serve as underground drainage conduits within local groundwater aquifers. Of primary importance are the Spiro, Ontario and Judge tunnels. The Spiro and Ontario tunnels are considered transbasin diversions while the Judge Tunnel collects and discharges groundwater entirely within the Snyderville Basin and Park City Area.

The Spiro Tunnel extends from the Snyderville Basin to the west side of the Wasatch Front. This physical alignment has resulted in the drainage of some groundwater from the Salt Lake County area to Park City. The resulting transbasin diversion has been subjected to litigation establishing damages to Salt Lake County water users for the loss of annual flow attributed to tunnel drainage.

The Ontario Tunnel collects groundwater in-and-around the northern limits of Park City and in the Snyderville Basin then discharges to the Jordanelle Reservoir. As a result, groundwater is collected in the Weber Basin and discharged to the Provo River Basin.

The Judge Tunnel is entirely contained within the Snyderville Basin and Park City Area. The tunnel collects groundwater from local basins and discharges to existing streams within Empire Canyon north of Park City.

The overall groundwater system in the Snyderville Basin and Park City Area is very complex and the primary source of water for nearly all municipal uses within the area. As a result of the relatively high rate of residential and commercial growth in recent years, a high demand has been placed on the basin's existing groundwater resources. This has prompted the U.S. Geological Survey, Utah Geological Survey and Division of Water Rights to conduct various surveys to better delineate and characterize various bedrock aquifers within the overall groundwater basin.

The groundwater in general meets culinary standards, but varies with source. In the unconsolidated valley fill, some springs test high for sulfate, chloride, manganese, iron or cadmium, elements which may come from mineralized bedrock or mining waste. Drain tunnels produce water high in sulfate which is an oxidation product of sulfide metal ore. Other tunnel drainage contains traces of heavy metals such as zinc, lead and arsenic in addition to substantial amounts of iron and manganese. Park City treats the Spiro drain water to remove arsenic, among other constituents.

19.2.6 Ogden Valley Groundwater Basin

The Ogden Valley groundwater basin is structurally bounded on both the east and west by faults that dip toward the middle of the valley. Basin fill consists of unconsolidated deposits of gravel, sand and clay at least 600 feet thick. Some areas of the lower basin have demonstrated instances of multiple confining clay layers creating artesian conditions in some isolated areas including Ogden City's culinary water well field. The well field has proven to be a major source of culinary water for Ogden City with an estimated annual production rate of 16,500 acre-feet per year. Studies of artisan aquifer conditions indicate that under normal water years, these aquifers fill to capacity every spring by natural recharge with partial depletion by the end of summer.

Springs around the margin of the valley produce some water for local culinary and municipal systems from consolidated rock. Consolidated rock units range in age from Precambrian to Tertiary and range in hydraulic conductivity from virtually zero to open channel flow in cavernous limestone. Few wells produce from bedrock.

19.3 Groundwater Problems and Alternatives in the East Shore Area

From groundwater models developed through a joint agreement between the Utah Division of Water Rights and the U.S. Geological Survey, it has been demonstrated that groundwater levels in the East Shore Area have experienced significant declines in recent years. Records taken from field measurements at various well sites have documented groundwater declines of up to 50-80 feet in densely pumped areas for the time period of 1958 to 1985.

The completion of the model has provided the Division of Water Rights with data and information to formulate a management plan for the East Shore Area groundwater basin. The management plan established various restrictions of pumping rates and the development of new wells. A copy of the management plan can be attained from the Division of Water Rights in its Salt Lake City offices.

19.3.1 Current and Projected Groundwater Conditions

Groundwater models have been developed to better quantify the current relationship of groundwater decline versus current and projected pumping rates within the East Shore Area aquifer. Each model has been run with a number of scenarios incorporating different combinations of pumping rates at differing locations throughout the groundwater basin. Results from the various computer evaluations of the existing aquifer/groundwater system seem to indicate that significant declines in groundwater elevations will be experienced in the event pumping rates continue at current or increased levels.

With the assumption that current pumping rates will continue indefinitely, it is predicted that groundwater elevations will drop an additional 15 to 80 feet by the year 2020.

However, the overall storage of water in the East Shore Area aquifer is large. As a result, the aquifer is not in danger of depletion. Local and state water planners have time to develop and implement effective management policies to better manage the existing groundwater resources.

Despite the general decline in groundwater elevations, artesian pressure still exists in some parts of the area. Unused, deteriorated and uncapped wells discharge water to surrounding drainages, thus wasting water and creating flood problems in some places. This problem probably will continue and perhaps worsen as wells become older and are abandoned.

19.3.2 Alternatives

The current trend of declining groundwater conditions in the East Shore Area can be reversed, or effectively managed through two basic approaches: 1) implement recharge projects to supplement existing groundwater supplies, and 2) enforce restrictions on pumping operations within the entire East Shore Area.

Studies around the mouth of Weber Canyon have identified areas of relatively large declines of up to 50 feet for original groundwater levels. However, the area has also been identified as very favorable or conducive to recharge from the Weber River. The subsurface conditions within the immediate area consists mostly of coarse unconsolidated alluvial deposits with high storativity and hydraulic conductivities. As a result, surface flows could be injected into local groundwater aquifers, stored and pumped at other locations within the overall aquifer system with a managed level of groundwater declines. Similar situations exist along the Wasatch Front in Davis and Weber counties that would allow for the effective management of groundwater elevations and annual pumping rates.

The Division of Water Rights has completed a groundwater management study for the East Shore Area to address declining groundwater levels in local aquifers. The study establishes policies, guidelines, and limitations concerning the installation and operation of new wells.

Deteriorated wells with artesian pressure need to be repaired. Unused wells could be capped or provided with control valves. Where repair is impractical, drains could be provided to reduce flooding and provide opportunity for beneficial use.

19.4 Issues and Recommendations

Groundwater issues generally include declining groundwater levels and related problems associated with pumping costs and groundwater availability. These issues are being addressed by a number of ongoing studies and field evaluations by state and federal agencies.

19.4.1 Groundwater Management

Issue - The overall groundwater supply is in jeopardy of significant depletions in terms of both water storage and pumping levels in critical areas of the basin.

Discussion - Five of the six groundwater aquifers in the Weber River Basin are closed to further appropriations. The East Shore Area is not closed, but it is currently experiencing problems associated with prolonged periods where annual pumping rates exceed recharge rates.

A thorough and comprehensive study of groundwater problems in the Weber River Basin has begun by the Division of Water Rights with the ongoing preparation of a groundwater management plan for the East Shore Area and Bountiful Subarea. As the need for additional water grows, groundwater problems will likely develop in populated areas traditionally serviced by wells or major springs.

Recommendation - The Division of Water Rights should continue efforts to prepare and implement groundwater management plans, not only in the East Shore Area, but in other areas of interest such as Ogden Valley, Morgan County, and the Snyderville Basin and Park City Area. These management plans should provide criteria and policies to safeguard against uncontrolled reductions in groundwater levels and possible groundwater mining in severely impacted areas of the basin.

19.4.2 Artificial Groundwater Recharge/ Conjunctive Use

Issue - The M&I water within the East Shore Area supplied by wells is impacted by declining groundwater levels.

Discussion - If the East Shore Area continues to experience moderate to rapid levels of urbanization, local water providers will be faced with the necessity of either expanding existing surface water treatment and distribution facilities or increasing current groundwater pumping rates. The former option would require significant costs associated with the planning, design and ultimate construction of new and/or expanded treatment and distribution facilities. Construction of injection wells or infiltration beds strategically located near Weber and Ogden canyons would potentially recharge a relatively large area of the existing groundwater aquifer near the most populated portions of the East Shore Area. The recharged aquifer would then allow for increased pumping rates at existing well sites and help eliminate the need for the construction of large surface water treatment and distribution facilities.

Recommendations - Major water suppliers under the direction of Weber Basin Water Conservancy District, in cooperation with the Division of Water Rights and Division of Water Resources, should pursue the possibility of obtaining funds through the Central Utah Project Completion Act for groundwater recharge projects within the East Shore Area. ❖